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[0001] This invention relates to a targeting apparatus for use in performing endofemoral osteotomy surgery. The apparatus is also suitable for conversion so that it can be used in transfemoral osteotomy surgery. In this particular surgical technique the femur is exposed along a proximal-distal line, the soft tissue (skin, muscle) being folded back on each side to expose the bone. The proximal end of the femur is now opened as a "window" and a femoral prosthesis is inserted into the bone canal.

[0003] There are difficulties in both techniques in assessing the particular angular position of the prosthesis in the femoral canal and the exact location of the resectioning of the femur must be accurately judged. A further difficulty arises with regard to the placement of one or more retaining bolts towards the distal end of the stem of the prosthesis. These bolts or pins pass through the bone, the stem of prosthesis and out through the other side of the bone thus anchoring the prosthesis in position. It is difficult for surgeons to judge the exact position to drill the holes in the bone to coincide with the holes in the implant and it is also necessary to select the correct angular position of the prosthesis and therefore the holes. It is also difficult for the surgeon to judge the exact distance down the femur for the holes to achieve the correct leg length of the correction.

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SUMMARY OF THE INVENTION

[0005] According to the present invention targeting apparatus for use in performing endofemoral osteotomy surgery comprises a support element provided with a drill guide, a connector for securing the support element to the proximal end of the prosthesis to be implanted and which include a proximal location element which is shaped to extend around the great trochanter and muscles of the femur in which the implant is to be located, and an adjustor for adjusting the angular position of the drill guide in relation to the femur about a proximal-distal axis.

[0006] Thus, the apparatus can be used to accurately locate the angular position of the drill guide and the prosthesis (anteversion setting) and which can be used to drill the holes to take the retaining bolt or bolts in the bone.

[0007] Preferably the proximal location element is in the form of a curved arm connected to the support element and this arm can be substantially S-shaped.

[0008] The proximal location element can be arranged to be detachable from the support element, for example, by use of a plug and socket connection, and this can be of a triangular cross-section.

[0009] Two detachable alternative proximal location elements can be provided, one for use with a right femur and the other for use with a left femur.

[0010] The targeting apparatus according to the invention can also be used for performing transfemoral osteotomy surgery by the provision of suitable conversion features. Thus, the apparatus can include conversion means for converting it for use in performing transfemoral osteotomy surgery.

[0011] The conversion means can include a connector for securing the support element to a resected femur to allow this form of surgery to be carried out.

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[0012] Alternative devices are also provided for securing the support element to the prosthesis to be implanted and which is adapted to replace the shaped proximal location element.

[0013] This alternative device may comprise a substantially straight proximal arm adapted for connection to the support element.

[0014] When converted in this way the apparatus can embody the features set forth in British Patent Application Nos. 00 27698.0 filed 13 November 2000, 00 27700.4 filed 13 November 2000 and 01 05779.3 filed 8 March 2001.

[0015] The invention also includes a kit of parts to provide targeting apparatus for use in performing endofemoral and/or transfemoral osteotomy surgery comprising a support element provided with a drill guide, a connector for securing the support element to a prosthesis to be implanted when performing endofemoral surgery and which includes a proximal location element which is shaped to extend around the great trochanter and muscles of the femur, alternative connectors for securing the support element to a prosthesis to be implanted when performing transfemoral surgery, an adjuster for adjusting the angular position of the drill guide in relation to the resectioned femur about a proximal/distal axis, and a connector for securing the support element to a femur.

[0016] The kit of parts can also include a drill guide element which has a line of drill guide openings each of which is adapted to guide a drill and a connector for rigidly securing the drill guide element to the connector for securing the support element to a femur.

[0017] Also included in the kit of parts can be a drill guide for drilling openings through the bone and soft tissue when it has been folded back into position at the proximal end of the femur when conducting the transfemoral surgery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The invention can be performed in various ways and some embodiments will now be described by way of example and with reference to the accompanying drawings in which:

[0019] FIG. 1 is an isometric view from above showing the layout of the targeting device according to the present invention when set up for use in performing endofemoral osteotomy surgery;

[0020] FIG. 2 is an isometric view from a first side of part of the apparatus shown in FIG. 1;

[0021] FIG. 3 is an isometric view of part of the apparatus from the side opposite that shown in FIG. 2;

[0022] FIG. 4 is a diagrammatic side view of a femur showing how it is cut for performing transfemoral osteotomy surgery;

[0023] FIG. 5 is a diagrammatic perspective view showing how the "window" is formed in the femur for transfemoral osteotomy surgery;

[0024] FIG. 6 is an isometric view from above of the apparatus shown in FIG. 1 when converted for use when performing transfemoral osteotomy surgery and in position on the femur;

[0025] FIG. 7 is an isometric view from above showing part of the apparatus shown in FIG. 6 with the proximal location element detached;

[0026] FIG. 8 is a part cross-sectional view of the connector for securing the support element of the apparatus shown in the preceding figures to a prosthesis to be implanted;

[0027] FIG. 9 is a side elevation of a clamp device shown in FIG. 6 for securing the support element to a resected femur;

[0028] FIG. 10 is a front elevation of the clamp device shown in FIG. 9;

[0029] FIG. 11 is an isometric view of part of the support element;

[0030] FIG. 12 is a partial side view of an alternative embodiment of the clamp device shown in FIGS. 9 and 10;

[0031] FIG. 13 is an isometric view of the embodiment shown in FIG. 12;

[0032] FIG. 14 is an isometric view of the construction shown in FIG. 13 partially disassembled;

[0033] FIG. 15 is an end view of the device shown in FIG. 11 incorporating the alternative constructions shown in FIGS. 12, 13 and 14 and including visual indicator guides with the support element in a first position;

[0034] FIG. 16 is a similar view to FIG. 15 with the support element in a second aligned position;

[0035] FIG. 17 is an isometric view showing a drill guide which can be clamped into position to enable holes to be made through the bone and soft tissue when it has been folded back into a position on the femur;

[0036] FIG. 18 is a front elevation of the clamp as shown in FIG. 10 attached to a drill guide element;

[0037] FIG. 19 is a plan view from above the drill guide element shown in FIG. 18 in part cross-section on the line V-V of FIG. 19; and

[0038] FIG. 20 is an end view of the drill guide element shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0039] In endofemoral osteotomy surgery the proximal end of the femur is resectioned by removing its proximal end. The stem of the prosthetic implant is inserted into the proximal end of the bone canal and accurately located by the surgeon. The exact position of the femur must be accurately judged and the distal end of the stem of the implant usually carries one or more openings through which one or more retaining bolts are passed. Thus these bolts pass through

to be located. This enables a frame of the type described above to be employed.

[0052] Two S-shaped arms 11 are provided, one for use with a right femur and the other for use with a left femur, the appropriate arm being used.

[0053] To carry out the surgery relating to endofemoral osteotomy the surgeon first ensures that appropriate X-rays have been taken so that he can consider the amount of bone which needs to be removed from the femur. Once this has been decided the measurements are carefully taken for further use with the apparatus according to the invention.

[0054] The femur is appropriately resected and the prosthesis is inserted. It is then connected to the targeting device by means of connector 3 for connecting it to the support element 1. With the support element 1 now suitably connected it is rotated axially about a proximal-distal axis of the femur until the correct position of the drill guides 2 is achieved. They will have been previously set to an appropriate and predetermined position on the proximal-distal axis. A visual indicator guide arm 70 is attached to the L-shaped frame in the form of a rod and this can also be employed to achieve the correct position. With the targeting device accurately located the surgeon can drill the requires holes in the femur 6 and this can be done without interfering with the muscle 94.

[0055] The targeting apparatus shown in FIGS. 1 to 3 can also be employed for performing transfemoral osteotomy surgery by adding additional components.

[0056] In this surgical technique the femur is exposed along a proximal-distal line, the soft tissue (skin, muscle) being folded back on each side to expose the bone. The proximal end of the femur is now opened as a "window" and a femoral prosthesis is inserted into the bone canal.

[0057] FIGS. 4 and 5 show, in simplified form, how transfemoral osteotomy surgery is performed. The soft

member 33 one end of which carries an operating handle 34 and the other end of which is rotatably housed in the body 30. Thus, rotation of the handle 34 raises and lowers the clamp 31 which is also located by a retaining screw 35 which passes through a slot 136.

[0062] The lower end of the open jawed clamp is formed as a pair of curved tines 36 which are adapted to extend around the resectioned femur to which the device is to be clamped.

[0063] A guide in the form of a disc 38 mounted on body 30 are provided, the disc projecting below the lower end 39 of the body 30.

[0064] The boss 17 is located in a slot 40 in the body 30 and held by a nut 37 but is free to move so that the position of the clamp adjusts itself in relation to the adjustment bracket 12 to alter the radial distance from the femur 6.

[0065] In order to clarify the drawings in FIG. 6 the soft tissue T and bone which has been folded back to provide the "window" and expose femur 6 is not shown but the femur will be in the condition shown in FIG. 5.

[0066] To carry out the surgery relating to a transfemoral osteotomy the surgeon first ensures that appropriate X-rays have been taken so that he can consider the amount of bone which needs to be removed from the femur. Once having decided this the measurements are carefully taken for further use with the apparatus according to the invention.

[0067] The "window" is now opened to reveal the femur and the bone is cut appropriately to provide a proximal end C, indicated by reference numeral 49 in FIG. 5. The clamp 5 is now located in position on the end of the femur by tucking it around the femoral end and ensuring that the guide disc 38 is close up against the severed end 49. The positioning is achieved with a rotative movement. Once in place the handle 34 is operated to close the clamp and retain it in

place. The stem (not shown) of the prosthesis 4 is now inserted in the femoral canal and the frame in the form of the arms 10 and 11 is connected to it by means of the connector 3.

[0068] The nut 14 is released to allow the bracket 12 to move in slot 13 and so that it can be secured to femur clamp 5 by the boss 17 and nut 16 through the slot 15. The release of nut 16 allows slot 15 to be placed on boss 17 at the appropriate radial distance from the femur prior to subsequent tightening. It will be appreciated that the proximal-distal movement in slot 13 accommodates the leg length adjustment. The ante/retroversion (version angle) adjustment is now carried out by revolving the frame about axis of the prosthesis 4 and the particular angle adjustment is set by tightening nut 16. During this angular movement prosthesis 4 which is securely attached to the support frame revolves with it as do drill guides 2.

[0069] The proximal-distal positioning of the drill guides is set according to the pre-operative planning and they are now positioned by releasing nut 42 so that they can be located in contact with the cortex of the femur and the nut suitably tightened.

[0070] The drill guides can now be used to produce the necessary holes through the bone to accept the required bolts or pins.

[0071] In the arrangement described above two drill guides are shown but only one or any other number can be utilized if required.

[0072] The apparatus can be simply removed by releasing the stud 21 in prosthesis 4, releasing the nut 16 and removing the frame. The clamp 5 can be removed separately.

[0073] The "window" is now closed according to any known post-operative technique.

[0074] FIG. 11 shows an alternative embodiment in which the same reference numerals are used to indicate similar

parts. In this arrangement adjustable bracket 12 can be readily disconnected from first arm 10 of the L-shaped frame. In this construction nut 14 is shown as a hand nut and is carried on a boss 50 which has a bore 51 adapted to receive a spigot 52 provided on the end of the bracket 12. Boss 50 also carries a screw threaded locking nut 53 which can be advanced through a screw threaded bore (not shown) so that it engages against the spigot 52 where it is located in bore 51 to clamp it in position. This construction enables disconnection of the assembly without having to unscrew locking nut 14 thus enabling the leg length to be set without readjustment.

[0075] FIGS. 12, 13 and 14 show an embodiment construction for the open jawed clamp device and the same reference numerals are used to indicate similar parts to those shown in FIGS. 9 and 10. In this embodiment however, the boss 17 is replaced by a bolt 60 which extends through the slot 40 and carries a spacer 61. One end 62 of the spacer is dished to accommodate a part-spherically shaped washer 62. A second part spherically-shaped washer 64 is also located on the screw 60 and one side of this is housed in a dished portion 65 of the nut 66. The nut 66 has a circumferential groove 67 to accommodate resilient ring (not shown) which can act to retain a socket wrench during assembly. Each of the washers 64 and 63 also has a flat side which are located against the sides of slot 15 on bracket 12 when the whole construction is assembled together with screw 60 passing through the slot 15.

[0076] With nut 66 tightened, the assembly is tightly clamped together, but if the nut 66 is slackened the bracket 12 can align itself in three different directions by a movement of the part spherical washers in the spacers 61 and 65. This enables three relative rotations, one of which is the anteversion setting on the other two rotations enable

centering of the stem in the femur if the clamp is ill positioned on it.

[0077] As the attachment of the clamp to bracket 12 is also adjustable and can be clamped in position movement of the clamp in the direction of the arrows 68 on FIG. 13. This enables the automatic adoption of the femur diameter and once set can be tightly adjusted to provide rigidity of the assembly.

[0078] FIG. 15 shows how visual indicator guides can be provided. Thus, a visual indicator guide arm 70 is attached to the L-shaped frame 10 in the form of a rod which extends at 15° to the axis of the first arm 10. A second indicator guide 71 which is also in the form of a rod is attached at an angle normal to the longitudinal axis of the clamp main body portion 30.

[0079] Using the visual indicator guides the apparatus is placed in position with the clamp positioned perpendicular to the 90° knee flexion plane. This is the first position of the anteversion at 0° and this is shown in FIG. 15. In FIG. 16 the L-shaped frame 10 has been rotated until the visual indicator guides 70, 71 are parallel. In this position the frame 10 has been rotated through 15° in relation to the clamp 30. Thus, the neck axis is parallel to the axis of the frame 10 and the rotation of the frame has thus created an angle between the clamp and the frame which is the anteversion angle. The exact angle of anteversion can be read from a scale indicated by reference numeral 72 provided on the bracket 12.

[0080] The standard value of anteversion is 15° and this can be used as a datum when setting up the apparatus.

[0081] When the "window" is closed it is necessary to fold the soft tissue and bone which has previously been folded back to provide the window back into position and locate it around the installed prosthesis. FIG. 17 shows how a proximal drill guide 75 can be provided to guide

drills through the folded back "flap" and to enable the drills to line up with pre-arranged holes 76 provided on the prosthesis 4. This device is in the form of an open jawed clamping block 77 which is provided with a tightening screw 78 which passes through a threaded bore (not shown) in the block to extend into the gap 79 provided between a lower clamping jaw 80 and an upper clamping jaw 81. The clamping block 77 carries an arm 82 which supports a pair of drill guides 83.

[0082] As will be seen from FIG. 17 the prosthesis is provided with a series of openings 76. With the prosthesis in support element 1 and held by second arm 11 the clamping block is placed in position and the drill guides are aligned by the use of guide rods or drills 84. With the drill guides now aligned with openings 76, the clamping screw 78 is tightened to lock the clamping block in position. The rods or drills 84 can now be removed, the "window" is closed and the drill guides employed to guide the drill or drills to make openings in the flap of bone and soft tissue 48. The openings can then be located by passing wire hoops through the openings and suitably locating them thus ensuring that the flap of material is held in place.

[0083] FIGS. 18, 19 and 20 show apparatus for carrying out the first part of the transfemoral osteotomy surgery as shown in FIGS. 1 and 2 and utilizes the clamp device shown in FIGS. 9 and 10 for securing the support element to a resected femur. The apparatus includes a drill guide element 100 which is rigidly secured to the femur 6 by the open jawed clamp device which has a boss 17 located in a slot 40 in the body 30 and is held by nut 37 so that the position of the drill guide element 100 can be adjusted to alter the radial distance from the femur 6.

[0084] The drill guide element 100 comprises a semi-circular support 101 connected to a location bracket 102. This bracket 102 has a slot 103 through which the end

place. The drill guide element 100 is now placed and locked in position by nut 16. The element extends over the femur and the surgeon now opens the upper part of the femur by severing the soft tissue through the slot 101. This exposes the femur beneath it so that the surgeon can cut a proximal/laterally extending slot. The surgeon now drills a series of holes using the drill guide means through the soft tissue and into the bone. The row of holes in the bone provides a row of perforations which can be easily broken away to provide the side cuts M but leaving the two broken away parts of the bone still attached to the remainder by the soft tissue in the manner shown in FIG. 5.

[0090] The "window" now obtained can be used for the remainder of the operation and leaves the femur ready to receive the prosthesis.

[0091] Prior to opening the bone the drill guide element 100 will, of course, have been removed by releasing the nut 16 but the connector in the form of the clamp can be left in position. The same clamp is now used during the remainder of the operation to act as a connector for securing a support element provided with a drill guide to a prosthesis to be implanted and to a resectioned femur, and an adjuster for adjusting the angular position of the drill guide in relation to the resectioned femur about a proximal/distal axis as explained above.

[0092] The drill guide element can be used with the clamp in place on the targeting apparatus but if desired it can be removed and used separately with the drill guide element 100 as described above.

[0093] The targeting apparatus according to the invention provides a modular construction which includes a support element with a drill guide, a connector for securing it to a prosthesis, an alternative connector for securing it to the prosthesis, a clamp for securing it to the femur, a drill guide for drilling holes in the proximal end of the

prosthesis and a drill guide for drilling a line of openings in the proximal-distal direction when preparing the "window" when performing transfemoral osteotomy surgery. The modular construction allows the various parts to be assembled together as required. Alternatively only some of the apparatus is required when performing endofemoral osteotomy surgery. When supplied as a complete kit the various parts can be assembled together as required at the time.

[0094] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.